



*Johnson Space Center (JSC) Center Director Ellen Ochoa “JSC 2.0  
– an envisioned future” May 2013*

*JSC leadership in future exploration is possible because...  
we’ve made smart decisions about roles for commercial  
.... partners*

# Partnerships and the Future of NASA

Presented by:  
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Chief Scientist, International Space Station  
IAC-15-D3.1.2

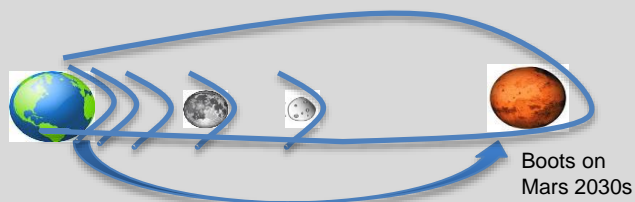


## Agenda

### Commercial Space Environment



### Commercial Space Strategy



### Partnership Strategy Summary

## Key Questions

Given the economic, technical, and relevancy realities, what should NASA's integrated vision and strategy be with regards to Commercial Space other than ISS crew and cargo servicing?

What types of Commercial Space partnerships will be most effective at helping NASA have a human presence on Mars and specifically, how should JSC engage in these activities?

To help JSC shape its future, what strategy is required?

# Role of Government



American Institute of Aeronautics and Astronautics (AIAA) Executive Director,  
Dr. Sandra Magnus

Hearing of the United States House of Representatives Committee on  
Science, Space, and Technology (February 27, 2014)

*“The role of government is to do the “hard” things; invest in the research and development that industry cannot, and to take on the tasks and push the boundaries that the private sector will not. Our strategy should encompass not only exploration but what we hope to accomplish in low Earth orbit and to encourage an economically viable industry there. We should consider how we want the U.S. to be leveraged for future roles in space, both in commercial and civil, in low Earth orbit and beyond. It should not be an “or,” it should be an “and”. “*

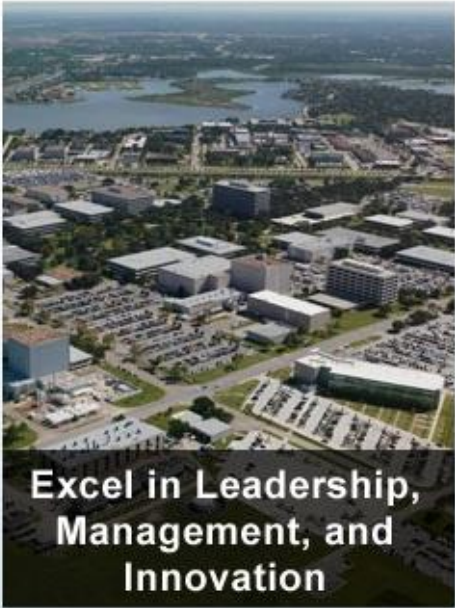




**Lead Human Exploration**



**Lead Internationally**



**Excel in Leadership,  
Management, and  
Innovation**



**Expand Relevance to  
life on Earth**

**JSC STRATEGIES SUPPORT EXPLORATION AND COMMERCIALIZATION**

- Strategy 1.1  
Exploit the ISS as a  
cornerstone of human  
exploration
- Strategy 1.2  
Enable the  
commercialization of LEO
- Strategy 1.3  
Extend human exploration  
beyond LEO

- Strategy 2.1  
Leverage ISS experience  
to lead international  
community participation  
in human space  
exploration
- Strategy 2.2  
Guide development of  
Agency Global  
Exploration Roadmap
- Strategy 2.3  
Champion international  
participation in the  
development of

- Strategy 3.1  
Lead through innovative  
technical and business  
management practices
- Strategy 3.2  
Lead by Fully engaging  
the human spaceflight  
team

- Strategy 4.1  
Intertwine JSC in mutually  
beneficial partnerships to  
maximize economic and  
societal impact
- Strategy 4.2  
Inform, educate and  
engage all generations to  
advance human space  
exploration
- Strategy 4.3  
Strategically communicate  
JSC's relevance in terms  
meaningful to our

# Partnership Development is a Key Enabler to Both Current and Future Agency Mission Objectives



## NSG 8-Verticals of NewSpace™

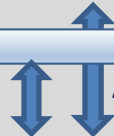


Existing Markets

Potential Markets



"Enable Commercialization of LEO"



International Capabilities

"Extend human exploration beyond LEO"



Domestic/International Partnerships for the Development of Deep Space Exploration Capabilities



"Mutually Beneficial Partnerships"



## EARTH RELIANT

MISSION: 6 TO 12 MONTHS  
RETURN TO EARTH: HOURS



Mastering fundamentals aboard the International Space Station

U.S. companies provide access to low-Earth orbit

## PROVING GROUND

MISSION: 1 TO 12 MONTHS  
RETURN TO EARTH: DAYS

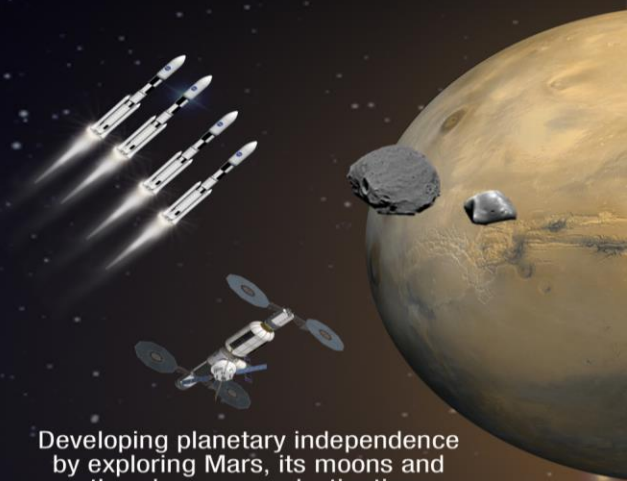


Expanding capabilities by visiting an asteroid redirected to a lunar distant retrograde orbit

The next step: traveling beyond low-Earth orbit with the Space Launch System rocket and Orion spacecraft

## MARS READY

MISSION: 2 TO 3 YEARS  
RETURN TO EARTH: MONTHS



Developing planetary independence by exploring Mars, its moons and other deep space destinations



# Technology Overlap w/ Commercial Space



*NASA's human exploration technology needs are not unique*

N-G 8-Verticals of NewSpace™



Existing Markets

Potential Markets

Exploration Technologies & Systems

Autonomous GN&C



Advanced Avionics



Advanced Power Systems



Entry, Descent, & Landing

Human Health Systems

Regenerative ECLSS

Adv. Lightweight Structures



Radiation Protection

Space Suit Technology

Mobility Systems

Manipulation Systems



Dextrous Robotic Systems

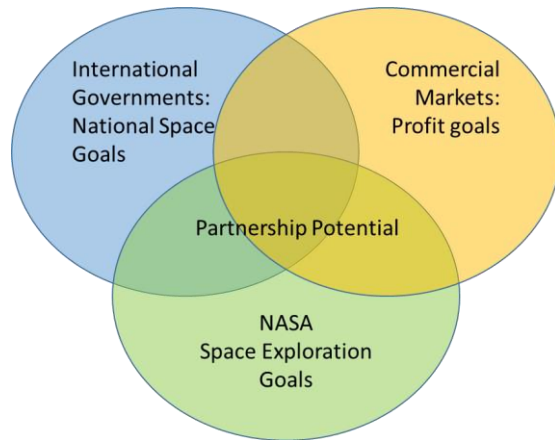
High Efficiency Propulsion



Energy Production / Storage



- **Key Questions**



- How can NASA best take advantage of Commercial Space goals that overlap with the human exploration goals of the Agency?
- Although the end application may be different, which underlying technologies would advance both beyond LEO exploration as well as Commercial Space markets?
- Which capabilities does NASA want to own and further develop? Which capabilities are better suited for commercialization with NASA as a buyer?

# Two-Pronged Strategic Approach

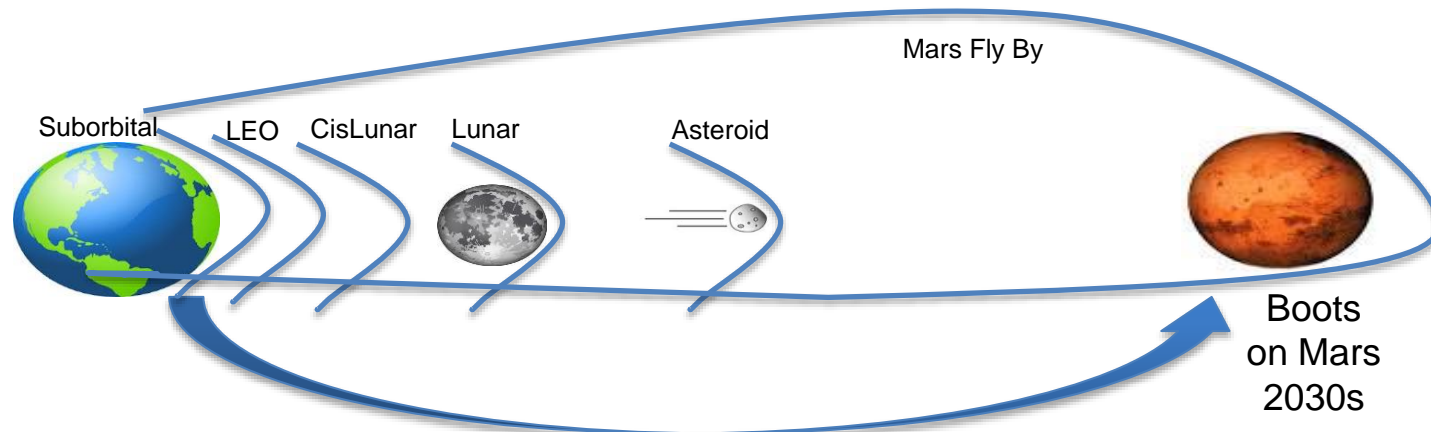


## 1) Close existing Mars mission technology gaps

- Co-develop new technologies for Mars mission to reduce the time and NASA funding required
- If it reduces total lifecycle costs, purchase capabilities / services in newly established commercial markets to free up NASA resources for beyond LEO
- Through support of Commercial Space Company LEO success, leverage commercial flight opportunities to perform risk reduction / tech demo activities

## 2) Maximize relevancy for future Mars mission

- Begin working with industry now to identify new market opportunities and sow the early seeds of market adoption as NASA begins to push the envelope of beyond LEO exploration





Technology Development

Enabling Systems

Integrated Demonstrations

Exploration Elements/Capabilities

Missions/Destinations

AR&D

Deep Space Nav

Adv. Comm (C&DH)

Modular Instru.

Common Core Flight SW

Pwr Gen

Pwr Storage – Adv. Chem Bat &

Fuel Cell

Pwr Dist. – AI wires

Hi Speed Heatshield

Multiphysics Model

Parachutes/Adv. Dec. Sys

EDL GN&C

Air Revitalization

Water Reclamation

Waste Recycling

Composites

Inflatable Techs

Multifunctional Struc

Multi-layer textiles

Water Membrane Evaporator

Rapid Cycle Amine Swing bed

Variable Regulator

PLSS

SAFER / Rovers

Robotic Arms

Robonaut

Green Propellant

Propellant-less Engines

Cryo Storage

Solar Array Perf

Nuclear Sys

Autonomous GN&C

Adv. Avionics

Adv. Pwr Sys

EDL

Human Health Sys

Regen ECLSS

Adv. Lwt Struc

Radiation Protection

Space Suit Tech

Mobility Sys

Manipulation Sys

Dexterous Sys

Hi Efficiency (ISP)

Energy Prod/Stor



Int. S/C Demo



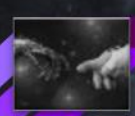
Spacecraft



Hab Demo



S/C Sys Testing



Human/Rob. Sys



SEP Demo



ISS



>20 day  
Lunar vicinity



Habitat Sys



EVA



Robotic Exp. Sys



Advanced In-space Prop



Surface Sys



>600 day  
Mars

# Partnership Example: R2



In 2014, Robonaut 2 (R2) was selected as the NASA Government Invention of the Year. R2 was co-developed with General Motors through a *Space Act Agreement*. One of the technologies resulting from R2 was a robotic glove that is a grasp assist device. The robotic glove can help astronauts reduce hand fatigue during spacewalks. It can also help factory workers grip tools longer with less discomfort and fewer stress injuries.

<http://spaceref.com/nasa-hack-space/robonaut-2-receives-nasa-government-invention-of-the-year.html>



## Partnership Example: ATK Space Systems Division



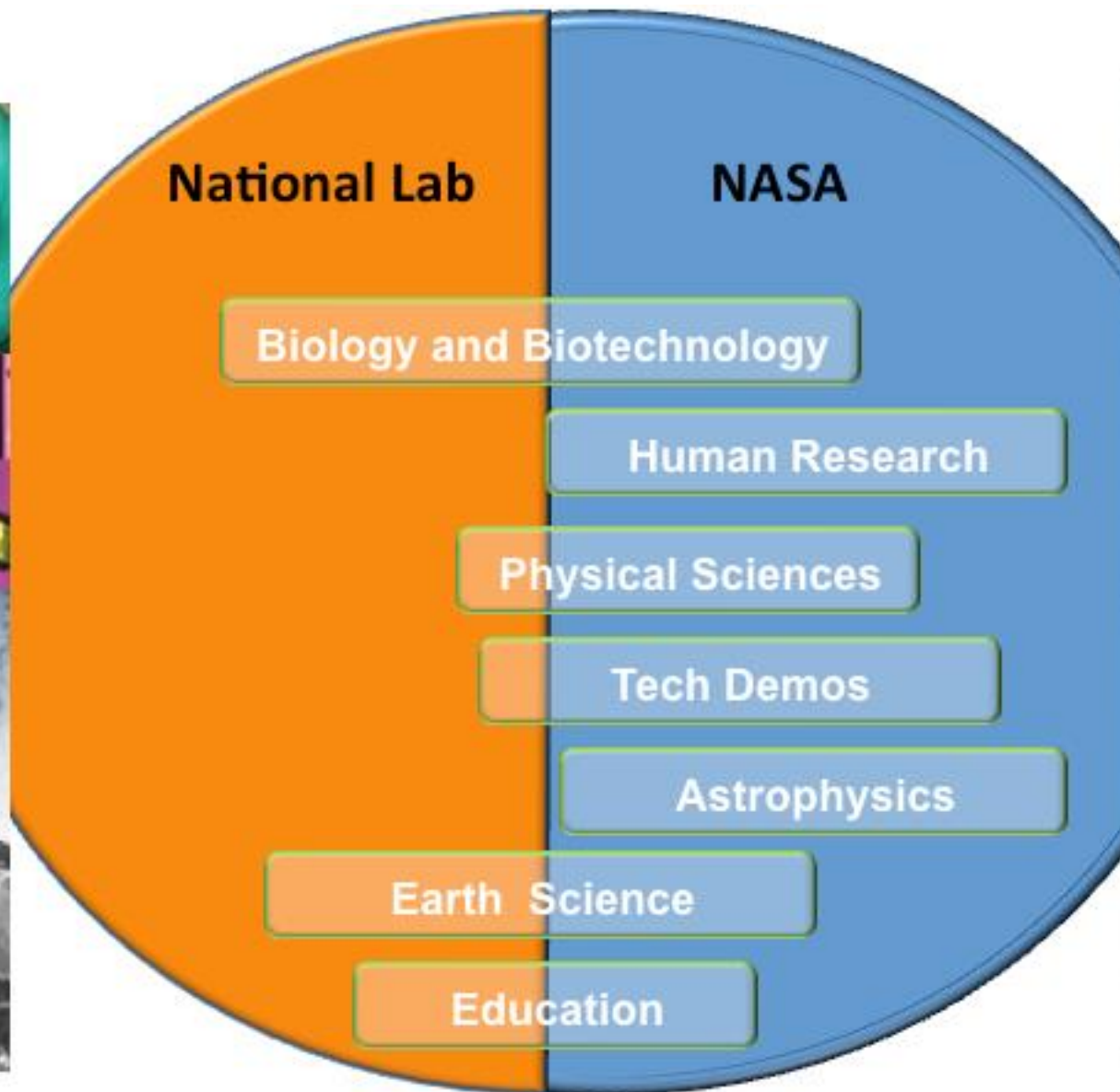
- In 2014, ATK and NASA signed a space act agreement to collaborate on technologies and new product development that meets the near term needs of the emerging satellite transport and space logistics industry.

<http://www.parabolicarc.com/2014/12/24/atk-nasa-collaborate-space-logistics-transportation/>





# ISS Utilization



# ISS Today: Partnerships



- **Non-Traditional**

- Earth Knowledge Acquired by Middle School Students (EarthKAM)
  - NASA education program that enables thousands of students to photograph and examine Earth from a space crew's perspective. EarthKAM has had participation by over 40 countries, including Argentina, Columbia, Dominican Republic, Kenya, and India.
- Amateur Radio on ISS (ARISS) –
  - Utilizes ham (amateur) radios to increase student interest in space exploration by allowing them to talk directly with crewmembers living and working aboard the ISS. ISS Ham Radio has had participation by over 40 countries, including Senegal, Brazil, Hungary, Ireland, Thailand and Turkey.

- **Inter-agency**

- Bilateral cooperation between NASA and the Department of Energy (DOE) on the Alpha Magnetic Spectrometer (AMS)
  - Science objective is to search for anti-matter from cosmic source
  - By July 2012, AMS had recorded over 18 billion cosmic ray events

- **Cooperative Agreement with Center for the Advancement of Science in Space (CASIS) for National Lab non-NASA uses of ISS**

# JSC Partnership Strategy Summary



- Space Act Agreements are a primary tool, with proven beneficial results, utilized by the Johnson Space Center to enable its Partnership Strategy
  - The Johnson Space Center currently has 383 active space act agreements with 188 Partners, 28 of which are Commercial Space companies.
- Building on the success of COTS, NASA/JSC is beginning to strategically engage commercial partners in its' exploration plans. JSC goal is to:
  - Engage in existing and potential Commercial Space markets to advance both human spaceflight technologies and relevancy
  - Identify and leverage international participation in the development of human space exploration capabilities
  - Be selective and prioritize partnerships based on established criteria weighing “opportunity vs. risk” (includes financial, technical, relevancy)
  - Leverage commercial objectives and actively pursue larger, more strategic partnerships for risk reduction and integrated technology demonstration purposes
  - Work with industry to identify and enable new markets that can be beneficial or perhaps even disruptive to human space exploration